PRS: Physics Reconstruction and Selection

e/gamma and JetsMET

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13-Dec-2000

PRS project

e/gamma and JetsMET groups

Status of work

Summary

Scope of the project

- The PRS groups will work on (and will also have responsibility for) the following tasks:
  - Detector simulation
  - Detector reconstruction
  - Detector calibration
  - Monitoring
  - Physics object reconstruction and selection (HLT)
  - Test beam analysis
- CoreSW/Comp will carry all other (offline) software not included above.
- Ditto for Trigger/DAQ (but scope of overlap is online farm and framework)

P. Sphicas/CERN-MIT
CPT Project Organization

CMS Steering Committee meeting
Nov 20, 2000

Major Dates in 2001-2003

DAQ TDR: end 2001; first draft: June 2001

- This means all (analysis) results in by May – at the latest

CoreSW/Comp TDR: end 2002

- Have not discussed how much (if any of PRS) will also appear in this TDR as well

Physics TDR: end 2003

- Suggestion: two volumes, like ATLAS:
  - Vol I: physics objects (jets, e, etc) calibration, efficiency, detector response & parametrization
  - Vol II: physics analyses (tanβ vs M_A plots)
- Intended organization:
  - Taskforces; Vol I is really our current system, with one additional horizontal bar called “TDR TF” (it’s finite term)
  - Vol II will need to wait until we evolve the organization to include the “physics” channels (e.g. Higgs, SUSY, etc)

DAQ TDR

(P.Sphicas, Nov.20, 2000)

- Currently, the DAQ TDR has one chapter dedicated to the High Level Trigger
  - It should describe:
    - Amount of data per detector (occupancies, etc)
    - Readout scheme (zero-suppression, selective readout etc)
    - Basic raw data format (time samples)
    - Basic reconstruction
    - Lvl-2 algorithms
    - Lvl-3 algorithms
    - Performance of all object identification
    - Basic trigger table that includes all discovery channels
    - Basic rate plots. We MUST have a credible scenario to get to the O(100) Hz level

HLT

- **Current work of the four groups: High-Level Trigger**
  - Lvl-1 trigger max. accept rate R_{max}=100 kHz
    - Current Lvl-1 is 30 kHz; the extra factor 3 is “safety”
  - HLT accept rate 100 Hz; need 1:1000 selection
- **Develop reconstruction algorithms & software implementing them, as well as selection in steps:**
  - “Level-2” trigger: anything one can do without using the tracker
  - “Level-3” trigger: include the tracker
  - “Level-4” trigger: full event analysis/cuts on physics
- **Planning:**
  - Lvl-2 step: measure rejection factor (factor ~10?) using only muon/calo data (~ ¼ of total?)
  - Lvl-3 step: ditto (factor 10?) including tracker

(P.Sphicas, 21-July-00)

ECAL - e/gamma

C.Seez - Coordinator

http://cmsdoc.cern.ch/Physics/egamma/www/egamma.html

Milestones:

- May 15: Electron & photon selection including tracker information
- Oct. 15: complete analysis and code for O(100Hz) selection
- Nov.01: in-situ crystal inter-calibration scheme defined

Organization:

- HLT & Calibration
  - Require/use e/γ physics object
- Testbeam
  - Verification of simulation
  - Conceptual framework of reconstruction

HCAL - Jets/MET

S.Eno - Coordinator

http://home.fnal.gov/~sceno/jpg/Default.htm

Milestones:

May 15: Jets and MET algorithms and software ready
Nov.01: Higgs and SUSY jets/MET analysis complete

Organization

- HCAL simulation
  - CMSIM/GEANT4/FAST
  - Verify shower model in G4.
- Calibration & Monitoring
  - from detector construction to in-situ calibration
- HCAL in ORCA
  - readout simulation
- Physics objects with HCAL
  - jets, MET & tau

Meetings

Biweekly video (VRVS) meetings:

All meetings start after 16:00 (to accommodate US/California)

--> 20:30 in India: OK?

Mon	Tue	Wed	Thu	Fri
RPROM --- SPROM	PRS μ --- PRS b/τ	PRS e/γ --- PRS J/M	DAQ* --- CAFE	Reserved

CPT Weeks:

CoreSW/PRS/TriDAS combined

April 23 and November 5 in 2001

CMS Weeks:

Mar. 5, Jun. 18, Sep.3 , Dec. 3 in 2001

Monte Carlo Samples
(cms116)

QCD: 10-470GeV

Et	events
10-15	100k
15-20	127k
20-30	196k
30-50	103k
50-80	42.7k
80-120	16.1k
120-170	11.5k
170-230	1.28k
230-300	1.28k
300-380	1.28k
380-470	1.28k

Total 600K

Min-bias 119k

Signal

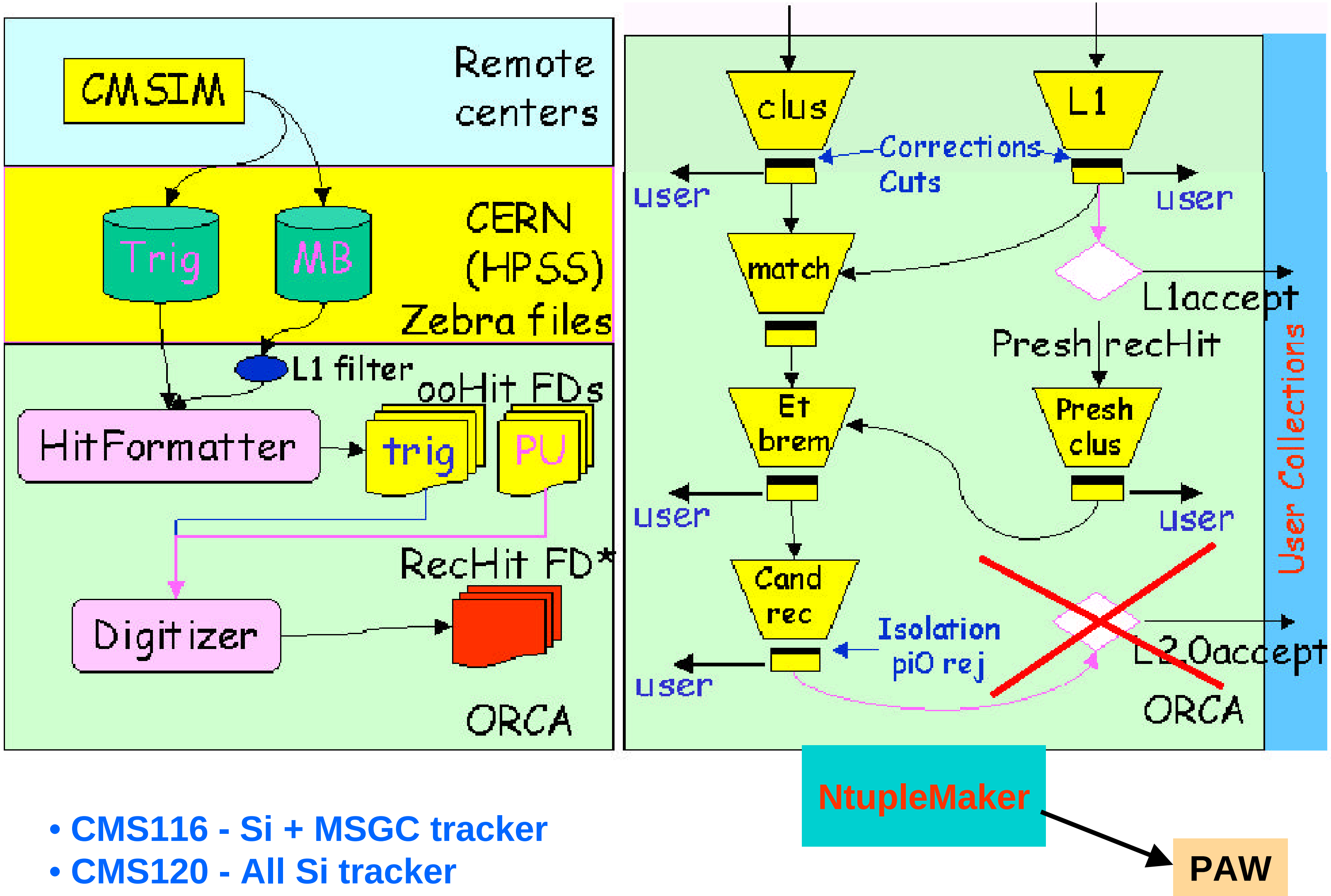
- ttH(110), H->bb 4.1k
- qqH(135), H->tau+tau
  - e+j 3.0k
- h(200)->tau+tau
  - ej/emu/jj 4.0,4.0,4.5k
- h(500)->tau+tau
  - jj 6.5k
- Sugra 4.8k

Single particle

- pion (5,30) 3.9,2.8k
- elec.(?)

(as of July, 2000)

Production & Analysis



- CMS116 - Si + MSGC tracker
- CMS120 - All Si tracker

e/γ

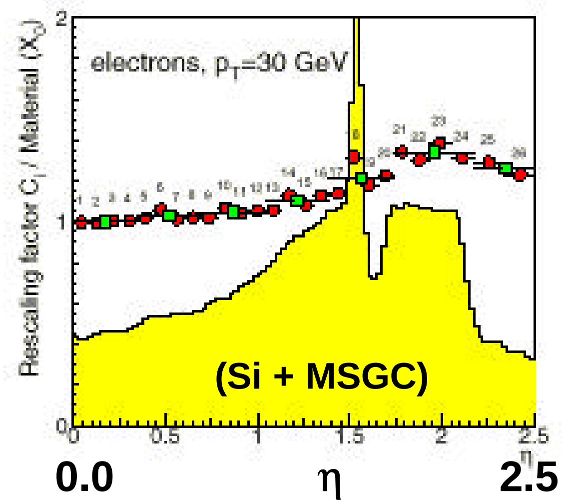
Signal: electrons and photons (isolated)

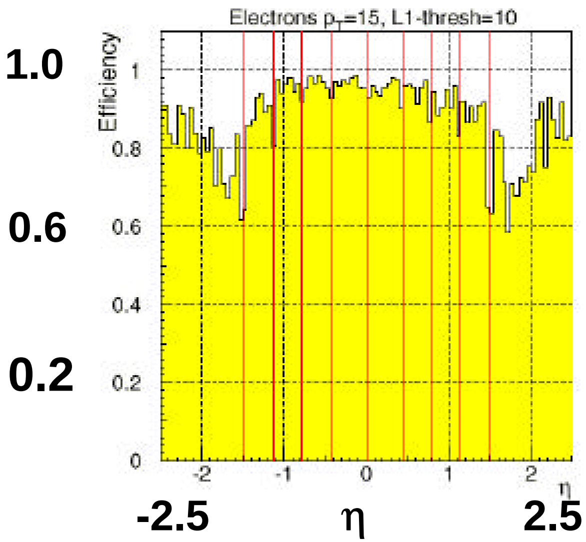
Background: single pi0 from jet

-> isolataion cut and pi0 rejection.

-> recovery for brems and conversions in tracker material in 4Tesla field.

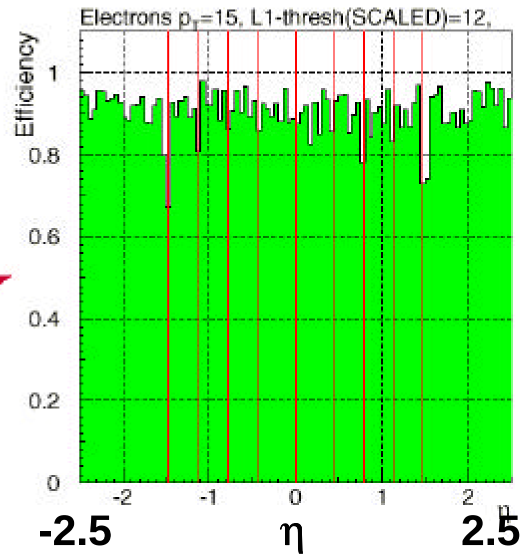
Rescaling factor and X0





L1 efficiency

rescaling E_T sums



e/γ - L2 selection

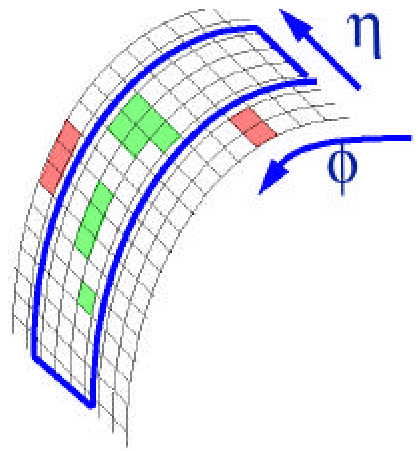
- Go for an 85% efficiency on single electrons at threshold for our target single electron trigger at 35 GeV
- A 5% loss is assigned to the Et cut which is the most effective (brems correction, ET calibration etc.)
- A total 5% loss is assigned to the H/E + π^0 cuts which act on endcap and barrel rates separately
- Another 5% loss is allotted to the Isolation cut
- Because most of the cuts are slightly P_t dependent, the plateau efficiency will be larger

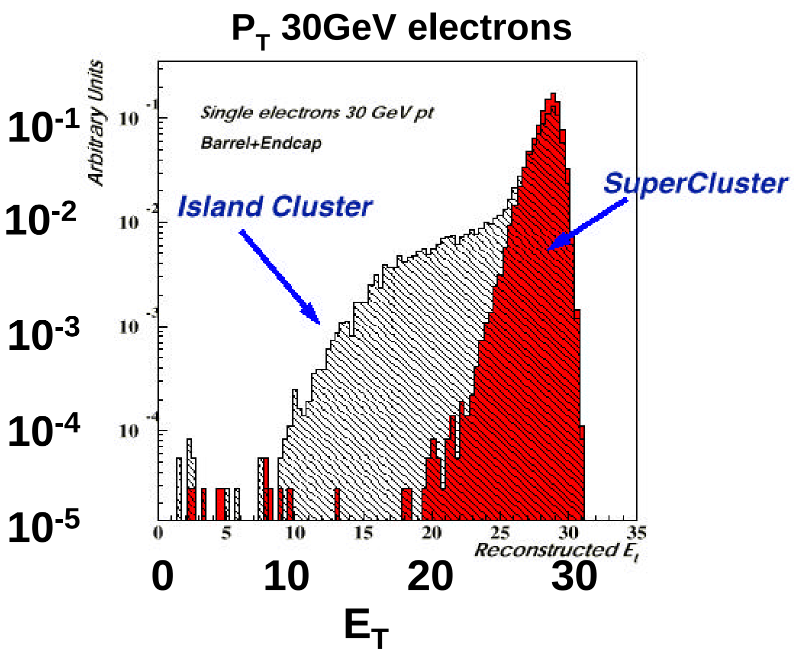
(E.Meschi, 21-July-00)

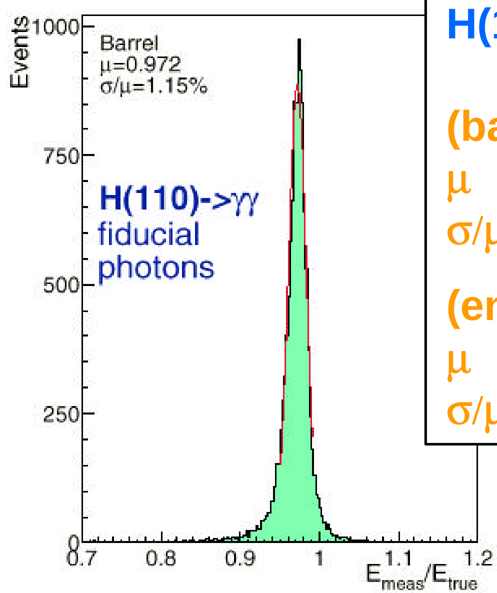
e/γ - brem/conv. recovery

SuperCluster Algorithm (example algorithm)

- look fo a "seed" island cluster above some threshold
- define a road (in phi) around the seed
- collect all isalnad clusters in road
- make a "cluster of clusters"
- recalculate the energy and position







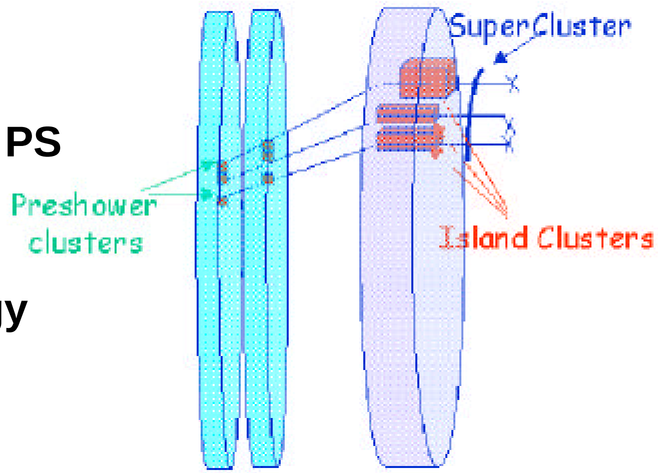
H(110)->γγ

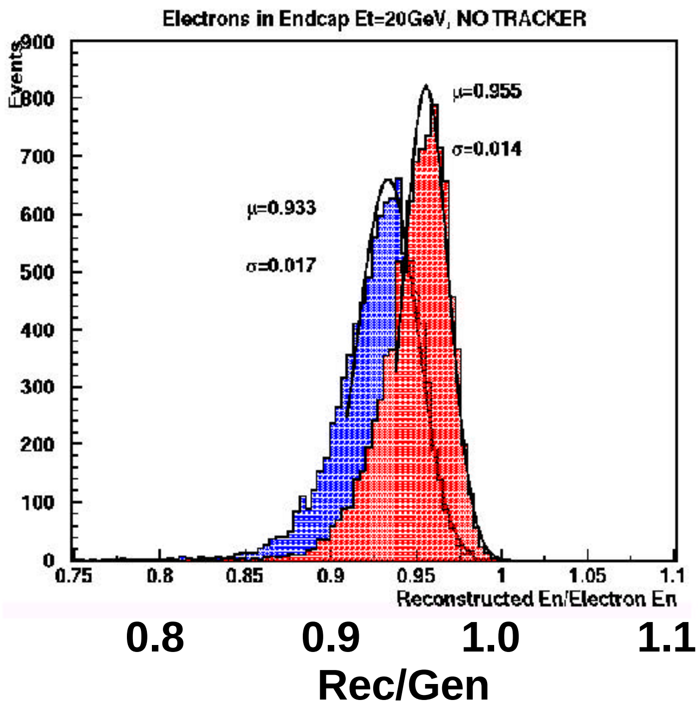
(barrel)
μ 0.972
σ/μ 1.15%

(endcap)
μ 0.970
σ/μ 1.81%

e/γ - preshower

- Reconstruct SuperCluster in EE
- Loop over the of components, extrapolate to PS
- Look for PS cluster in a narrow road
- Add PS cluster energy to SuperCluster energy



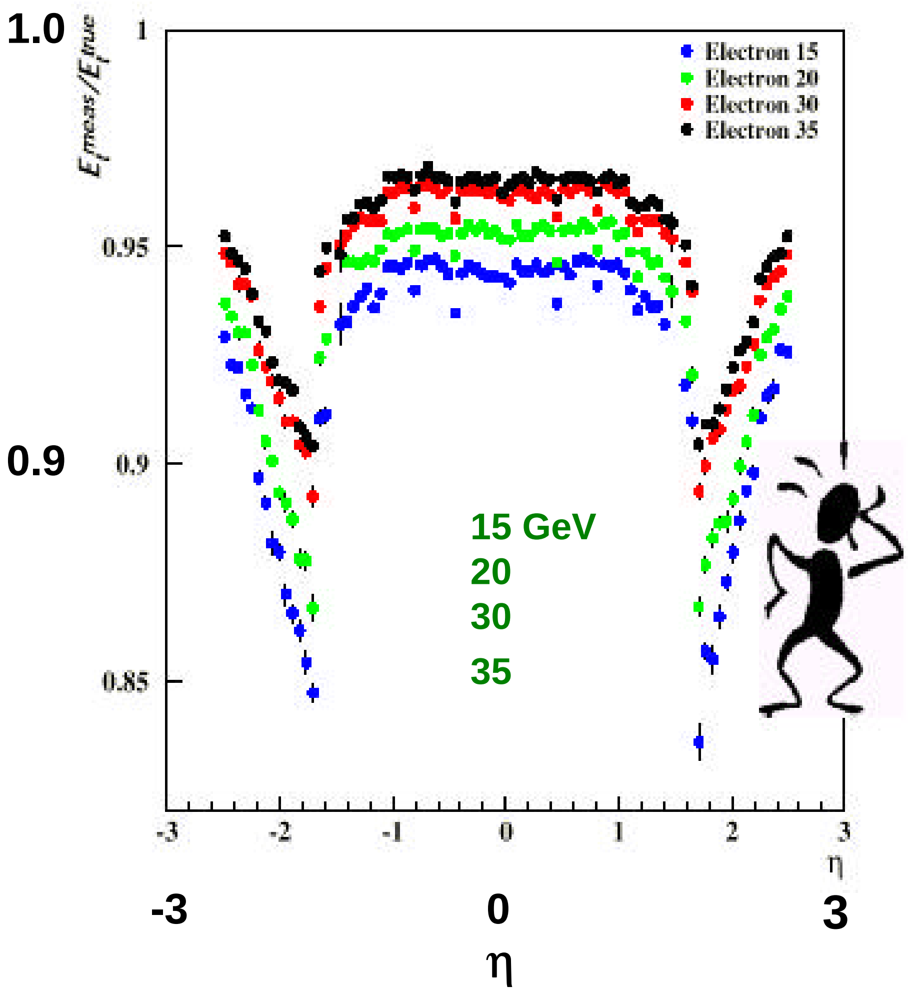


Electrons in Endcap
P_T = 20GeV, (no tracker)

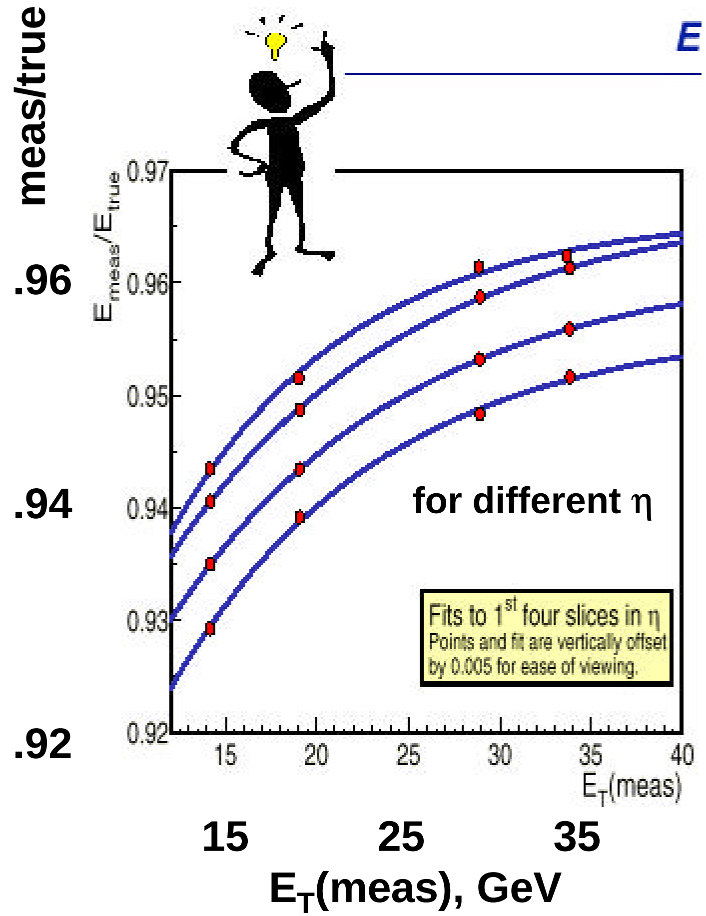
	before	after
μ	0.933	0.955
σ/μ	1.82%	1.47%

e/γ - Energy Calibration

E_T(meas)/E_T(true)

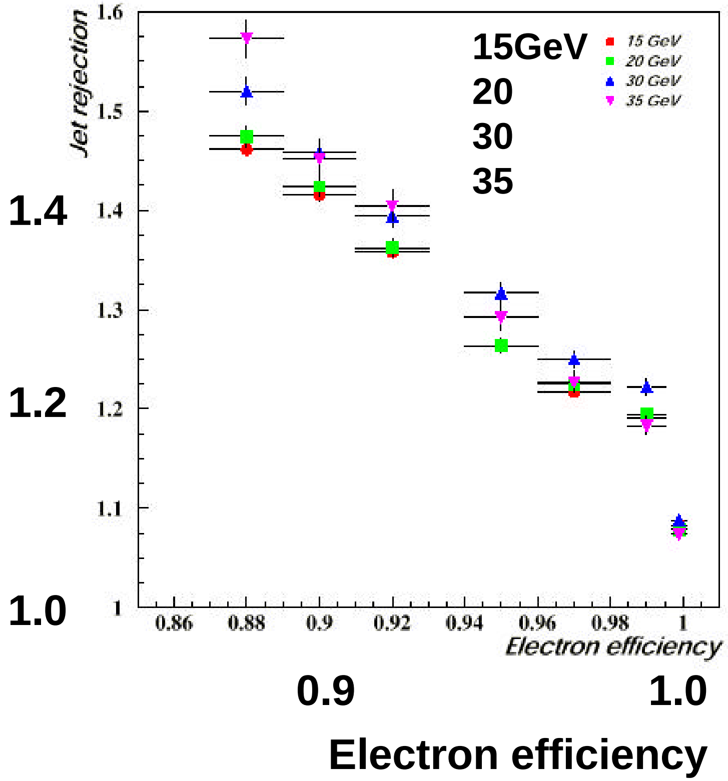


E_T - η dependent correction

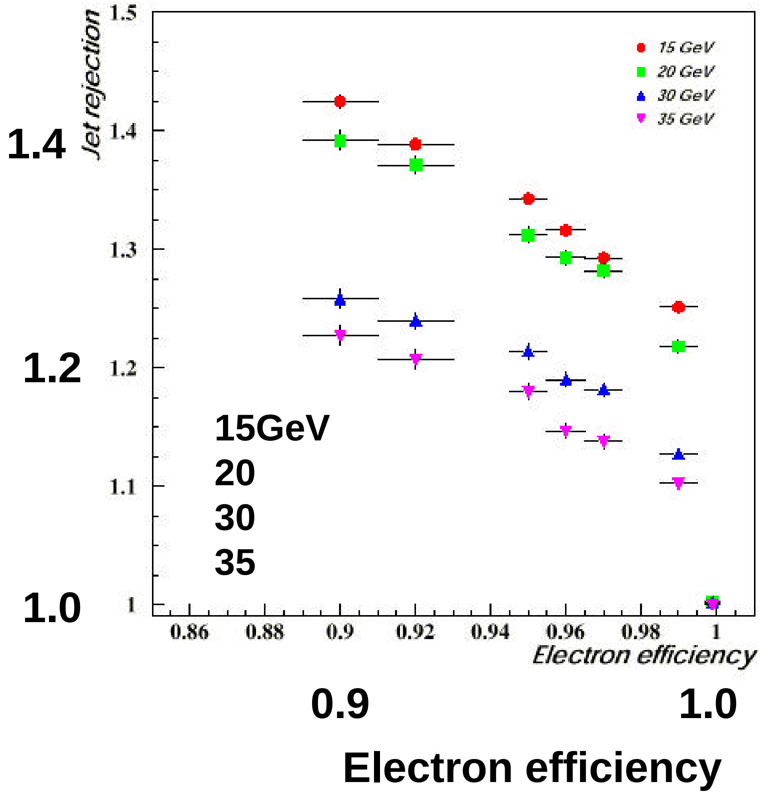


e/γ - H/E and pi0 rejection

jet rejection by H/E



Jet rejection with neural network using energy distribution (1st & 2nd moment) in 5x5 crystals

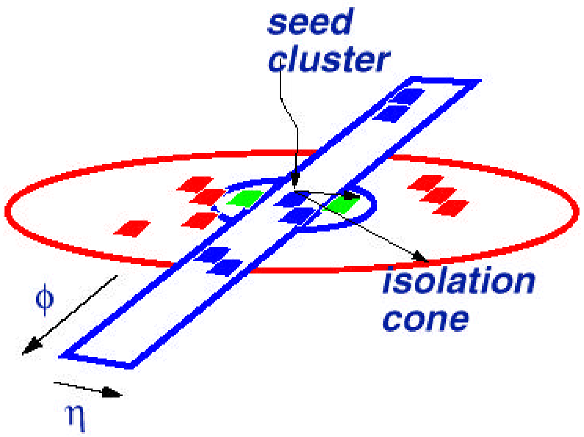


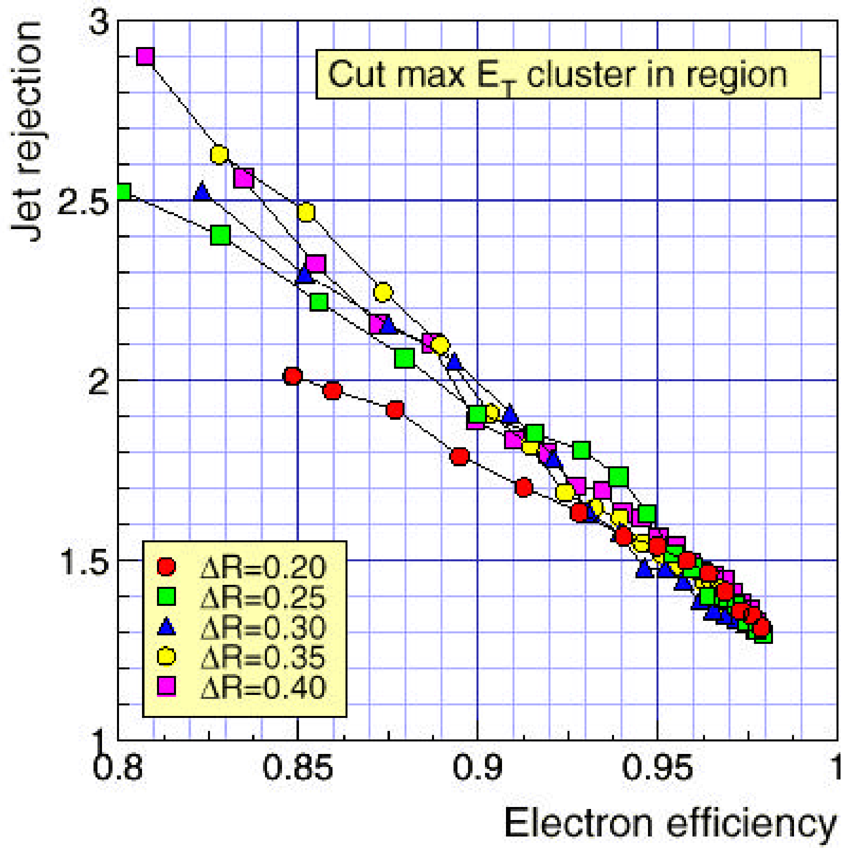
Marginally useful for large efficiency (over L1).

e/γ - isolation

Variable:

sumE_T or maxE_T
in isolation cone
excluding
η slice, |Δη|<0.05
guard ring, |ΔR|<0.08





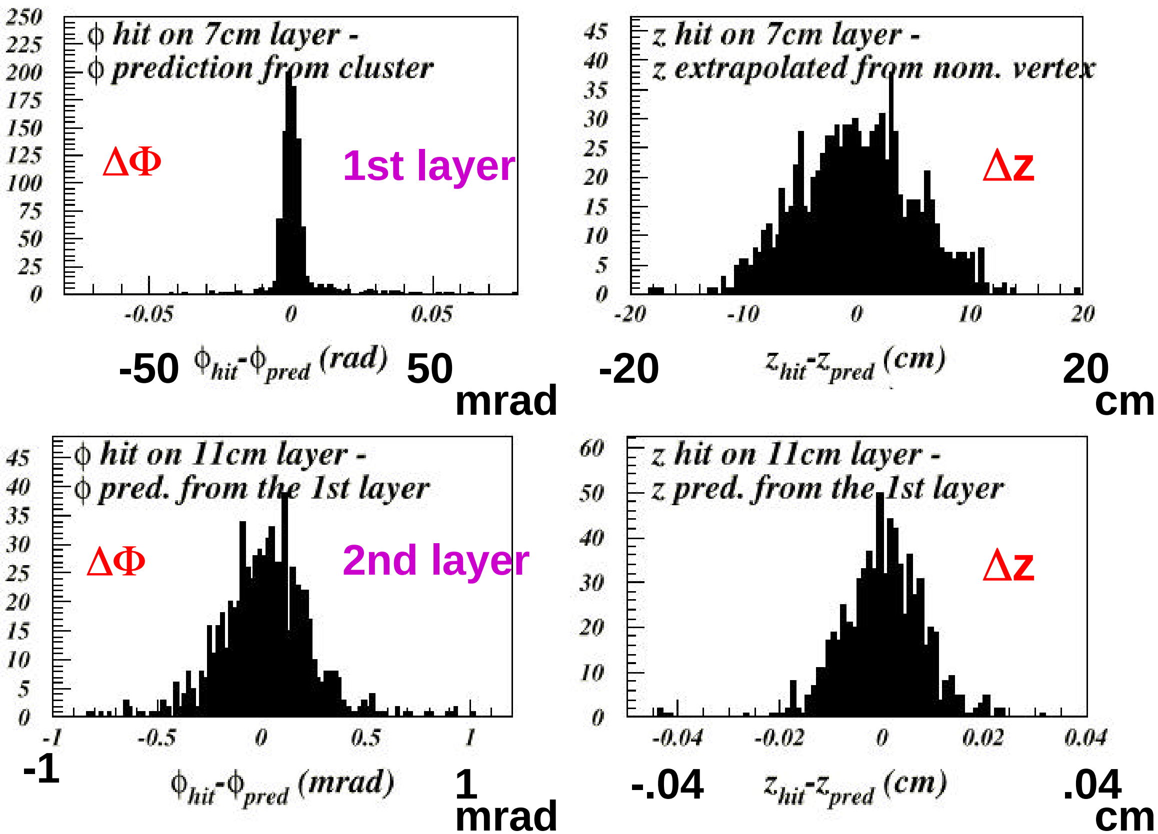
e/γ - pixel hits (L2.5)

(K.:assila-Perini)

- Propagate trajectory assuming vertex and charge
  ECAL cluster -> 1st pixel layer -> 2nd pixel layer (cms116)

- Look for hits

PT 15GeV L1 e^+/e^-



Efficiency:

94.6% w pile-up
93.6% w/o pile-up

for e+/e-
from H->4e

jet rejection:

x12

for L1-accept
QCD 30-50GeV
events

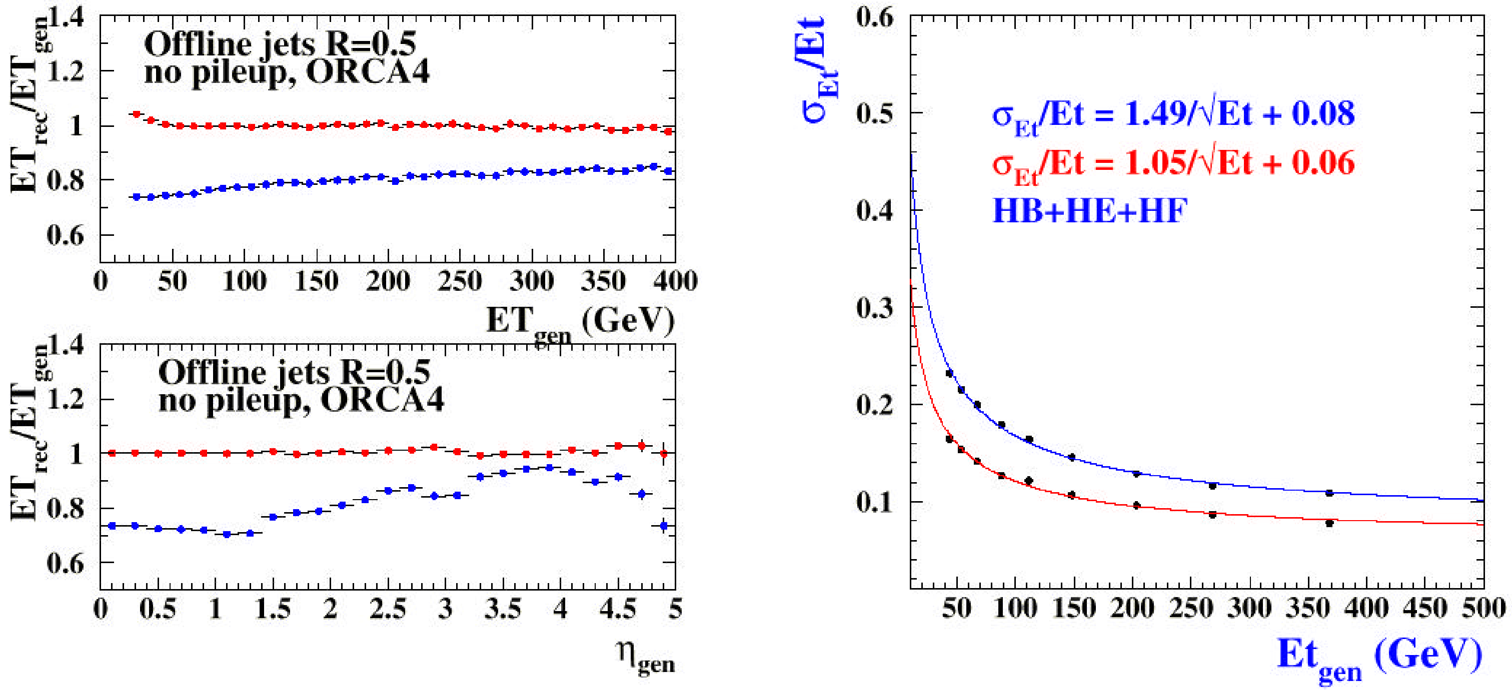
-> cmsim120
for all Si tracker

Jets/MET

Signal: jets, MET, tau
Background: QCD jets

-> improve resolution and E_T scale at every level (L1-L4)
-> reject fake jets due to pile-up at 10E34

Jet ET correction - (E_T,h) dependent (L2)

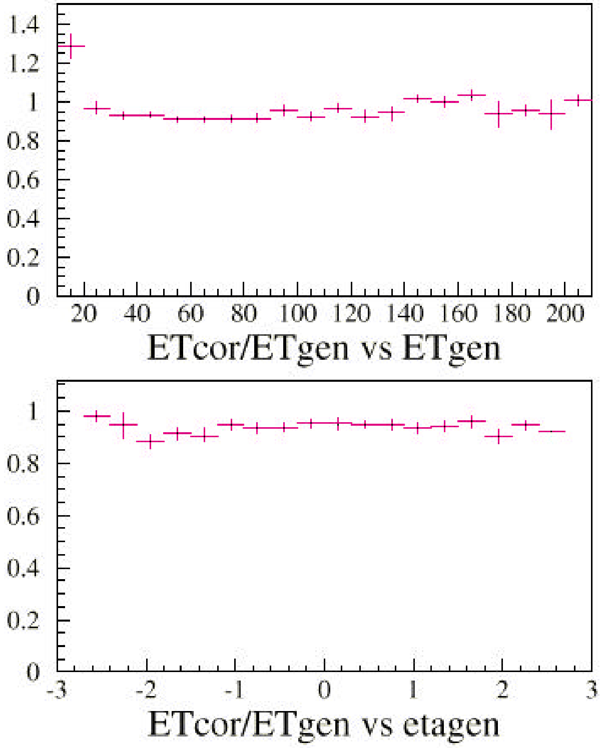


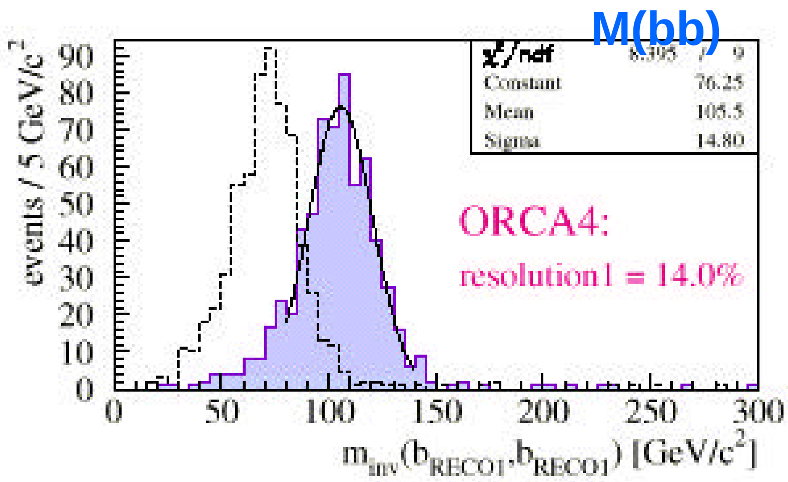
- Different correction factors for L1-jet, b-jets, tau-jets
- Luminosity dependent (pile-up enegy subtraction)

b-jets

Apply same correction to b-jets from H->bb

After correction





The corrections seem to work ok also for b-jets, even though the overall scale is lower by ~5%.

Jet energy correction
without: 19%
with: 14%
(CMSJET 15%)

(S.Arcelli & V.Drollinger)

Jet energy correction to MET

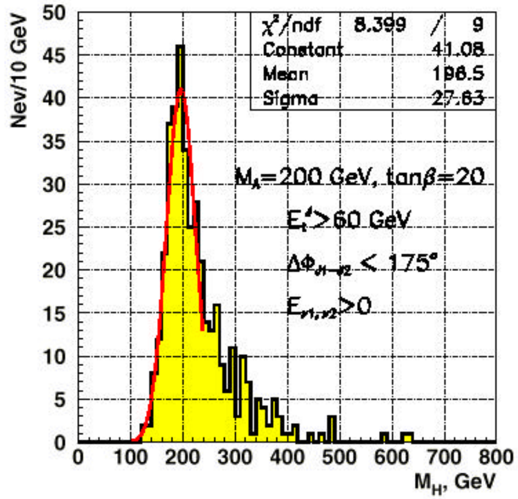
$Ex' = Ex + \Sigma\ (\ \Delta(Ex\text{-}jet))$
$Ey' = Ey + \Sigma\ (\ \Delta(Ey\text{-}jet))$

Mass for A -> $\tau\tau$ -> j + j + MET

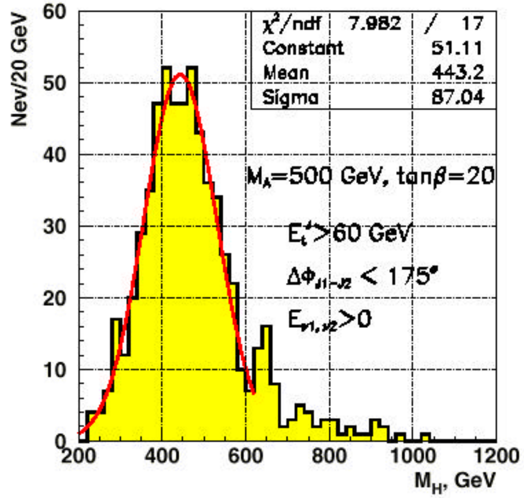
cmsim116/orca4 data at $L=10^{33} cm^{-2}s^{-1}$

200GeV

σ / M = 14 %



σ / M = 20 %



500GeV

cmsjet : 13 % 13.4 %

(S.Abdoulline &A.Nikitenko)

Need a lot more work for MET!

tau jets

tau jet:

narrow (one prong) jet

L1/L2:

use only calorimeter

L1: 0.087x0.087

L2: individual crystal

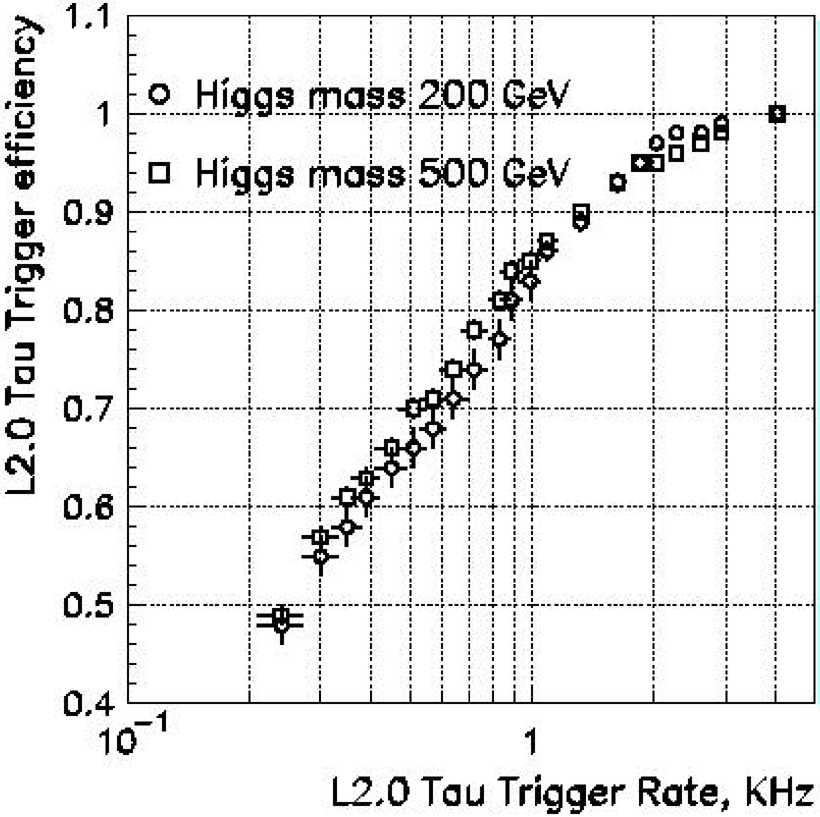
L2.0 Tau trigger

1. reconstruct a Jet*
2. calculate e.m. isolation :

   $P_{isol} = E_t^{ecal}(R < 0.4) - E_t^{ecal}(R < 0.13)$

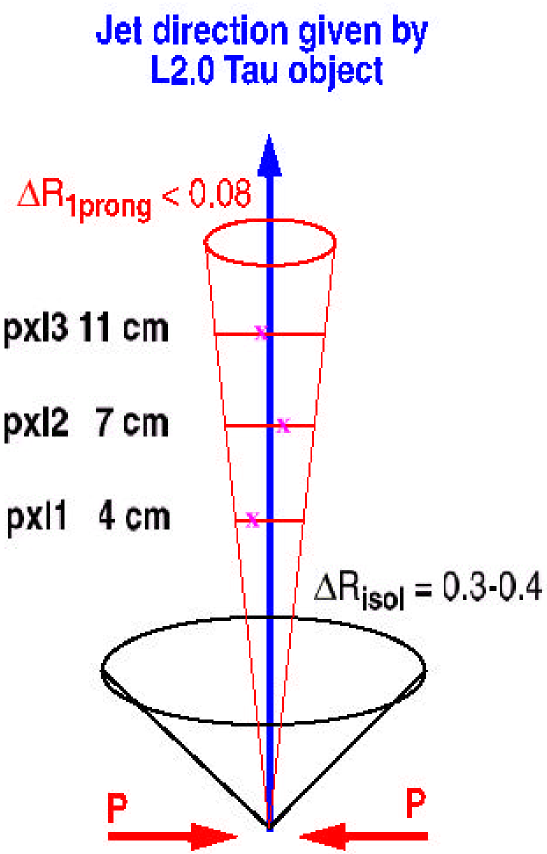
3. accept event if $P_{isol} < P_{cut}$

gg->bbA, A->2τ->h⁺ + h⁻ + X



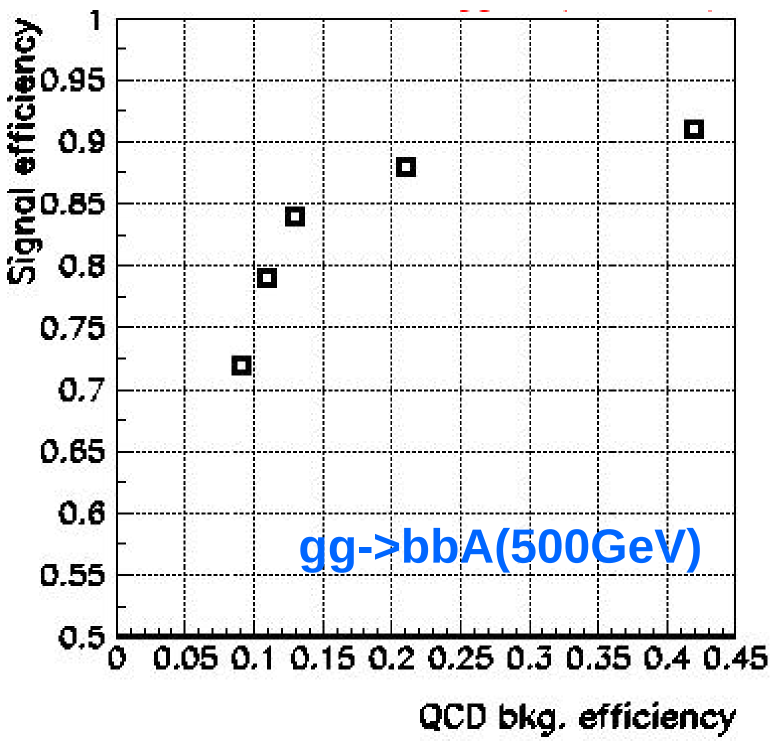
(A.Nikitenko)

tau jets at L3



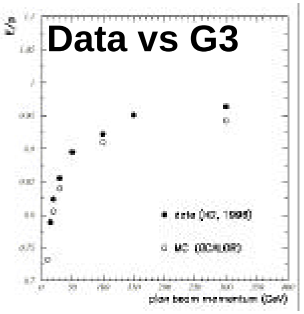
1. Tracks are reconstructed with 3 pixel layers only within a cone given by L2.0 jet axis.

2. Isolation cuts: tracks in a big cone (0.3-0.4) vs. a small cone (~0,1), PT(tr)>1-2GeV



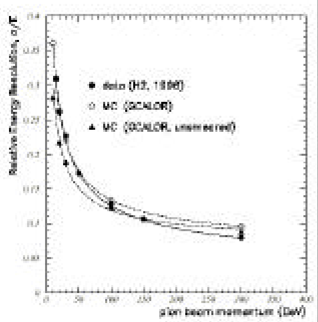
(Nikitenko & Kotlinski : cms116 analysis)

Hadron Shower Simulation

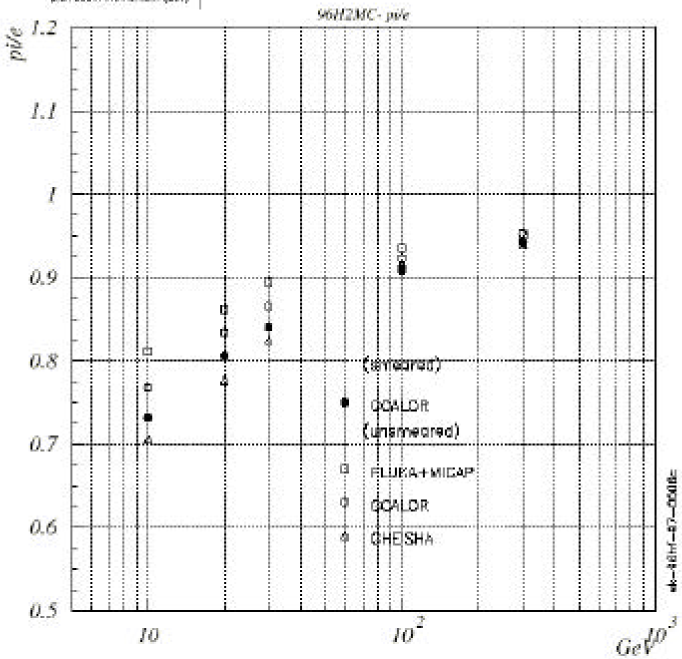


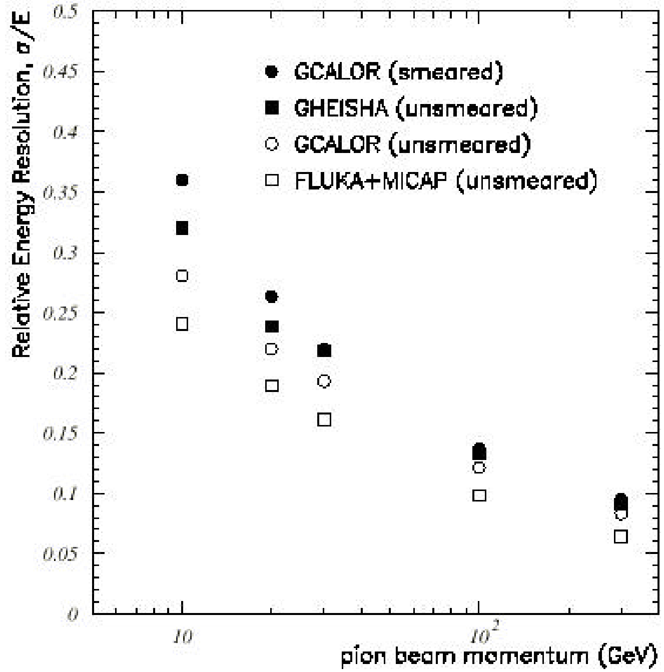
G3- 1996 test beam simulation

E(beam)=20 - 300GeV



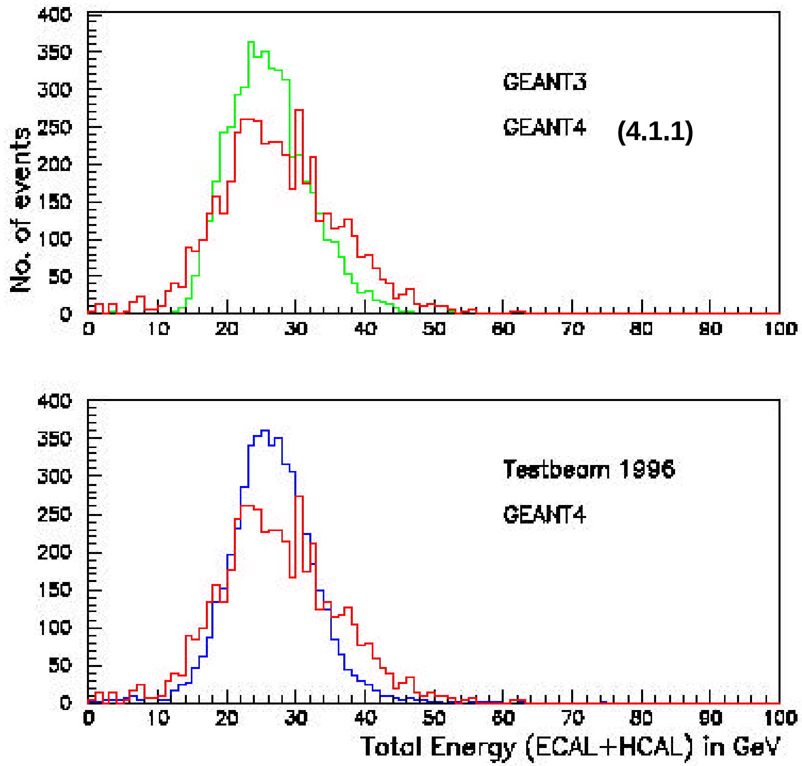
pi/e **resolution**





Needs: clean data below 20GeV
verify/tune G4

GEANT4: 30GeV pions



Total energy (ECAL+ weighted HCAL) for 30 GeV pions,

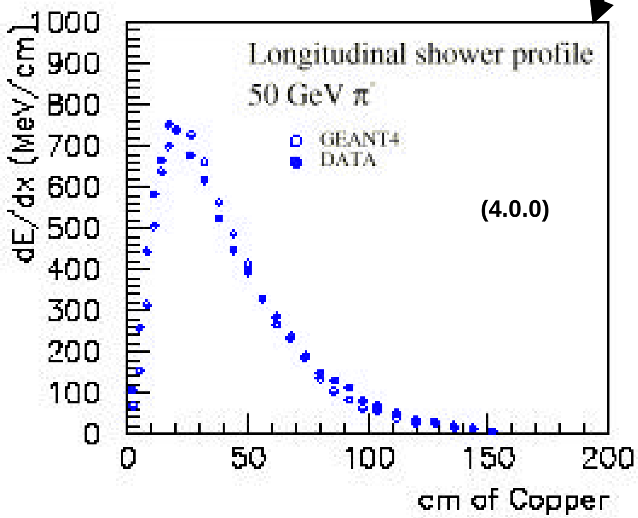
– GEANT4, – GEANT3, – Testbeam

(Sudeshna Banerjee, Oct.2000)

G4 shows wider distribution than G3 and data. We need to check our program.

Note that our previous G4 simulation for HCAL alone with earlier release (4.0.0) of G4 showed good agreement between G4 and data.

We need to debug our current code and also try the latest version of G4 (4.2).



Summary

A lot of work is required for the DAQ TDR/HLT section.

- Amount of data per detector (occupancies, etc)
- Readout scheme (zero-suppression, selective readout etc)
- Basic raw data format (time samples)
- Basic reconstruction
- Lvl-2 algorithms
- Lvl-3 algorithms
- Performance of all object identification
- Basic trigger table that includes all discovery channels
- Basic rate plots. We MUST have a credible scenario to get to the O(100) Hz level

low/high luminosity

calibration (in-situ)

physics channels

tracker material (cms120)

CMSIM - many detector geometry (cables, mech. structure) outdated.

ORCA - need more experts. (local experts)
integration of existing algorithm (E_T calibration, MET, tau etc.)

OSCAR(G4) - need verification/tuning
link to ORCA